



Palpitation and virtual-assisted lung mapping: not mutually exclusive but complementary to facilitate sublobar lung resection

Masahiro Yanagiya, Masaaki Sato

Department of Thoracic Surgery, The University of Tokyo Graduate School of Medicine, Tokyo, Japan

Correspondence to: Masaaki Sato. Department of Thoracic Surgery, The University of Tokyo Graduate School of Medicine, Tokyo, Japan.

Email: SATOM-SUR@h.u-tokyo.ac.jp.

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We thank Goto T. for the valuable comments on the limitations and problems of virtual-assisted lung mapping (VAL-MAP) and the claim that finger palpation is superior to this technique in response to our recent paper about VAL-MAP (1,2). We wish to make four points to support our contention that VAL-MAP is necessary.

First, we did not intend to discount the value of conventional palpation in association with the use of VAL-MAP. Although we did not clearly state this in our original paper, we often use palpation in combination with VAL-MAP. In our opinion, Goto's statement that "(*in the use of VAL-MAP,*) the operators cannot directly determine the tumor location by touch" (1) revealed a misunderstanding of aspects of the practical use of VAL-MAP. To the best of our knowledge, most surgeons using VAL-MAP also confirm the location of a tumor, especially when that tumor is palpable (e.g., a solid nodule), by palpation using either a finger or metal suction probe, even when VAL-MAP markings have been perfectly placed. Additionally, if a tumor is easily palpable, we generally do not bother to perform VAL-MAP.

Second, palpation cannot precisely locate some tumors. As many Japanese experts have reported, some pulmonary tumors are impalpable (3,4). One of these authors (MY) reported an impalpable tumor that finally required lobectomy rather than wedge resection and turned out to be benign (5). Indeed, the statement "*In our experience, most tumors are palpable, even in case of pure ground-glass neoplasms (1),*" suggests that Goto has encountered impalpable tumors. The most important question that thoracic surgeons then face is how to deal with an impalpable tumor. Furthermore, it is

not always possible to accurately predict the intraoperative palpability of a pulmonary nodule. For example, even though a tumor appears likely to be palpable on CT images, palpation may be hindered by a neighboring scar or fibrosis. Another group recently reported a case in which VAL-MAP greatly facilitated accurate resection of pulmonary metastases in a patient who had previously undergone open thoracotomy (6). During surgery, extensive tight adhesions were encountered. After dissecting these adhesions, the metastatic tumors were indistinguishable from thick fibrotic pleura by finger palpation, whereas VAL-MAP markings enabled localization of the tumors (6). As shown in multiple observational studies and case series, palpation is not always reliable (3-5). At minimum, palpation depends largely on the surgeons' skills and experience, limiting its accuracy when performing pulmonary resections. We consider that VAL-MAP minimizes such limitations, making sublobar lung resection more reliable and reproducible. We have sometimes regretted not having performed VAL-MAP after finding it difficult to palpate a tumor during surgery, whereas we have never regretted having performed VAL-MAP.

Third, the invasiveness and complications of VAL-MAP need to be addressed carefully; in Goto's letter "invasiveness" was not clearly defined (1). It is true that bronchoscopic procedures, including VAL-MAP, involve some invasiveness and can cause complications. However, no procedure is better than VAL-MAP in this respect. As we have discussed above, technical assistance is sometimes needed to localize a pulmonary nodule. CT-guided placement of a hookwire is a conventional means of localization; however, it has the potentially

Table 1 Inclusion criteria for virtual-assisted lung mapping

Patients with a suspected or diagnosed pulmonary malignant tumour for which thoracoscopic sub-lobar lung resection (wedge resection or segmentectomy^a) is indicated

and

- The tumour is expected to be hardly identifiable during surgery, *including but not limited to*
- A pure ground glass nodule
- A nodule <5 mm in diameter
- A nodule whose diameter is less than the distance to the closest pleural surface *and/or*
- Resection lines that need especially accurate demarcation for visualization during surgery, *including but not limited to*
- A nodule with a ground glass component, the extension of which is expected to be hardly identifiable during surgery
- A nodule for which extended or complex segmentectomy is necessary

^aThe surgical procedure was selected by the surgeon(s), taking multiple factors into consideration including, but not limited to: suspected diagnosis (primary or metastatic), estimated degree of malignancy (e.g., % of ground glass components in CT scan), the location of the tumour (close to the pleural surface or not) and patient's comorbidities.

fatal major limitation of risking air embolism, which was one of the motivations for developing VAL-MAP (7). We have published a systematic review of bronchoscopic marking techniques, including VAL-MAP, in which we demonstrated that bronchoscopic marking procedures have never resulted in serious complications; however, there may have been some publication bias (8). Additionally, although it has been claimed that one advantage of the palpation method is a shorter surgical time (1), a previous study has reported that VAL-MAP shortens surgical time (9). Indeed, as many thoracic surgeons have experienced, localization by palpation is usually quick and easy; however, when it is not, the procedure can become extremely time consuming and even nightmarish.

Fourth, in our studies we rigorously defined successful resections as complete resection of target tumors with resection margins larger than or equal to the lesion diameter, or ≥ 2 cm if the tumor was larger than 2 cm (2,7). Although unsuccessful resection rates were as high as 8.2%, the study was retrospective and normally inadequate resection margins were not regarded as clinically unacceptable in some cases (e.g., a 15-mm diameter pure ground glass nodule with a 12-mm resection margin).

One of the challenges in previous studies using VAL-MAP has been setting an appropriate control; this has resulted in the issue of effect size, as pointed out by Goto (1). It is easy to propose conducting a randomized controlled trial, but not so easy to achieve. We believe

that it would be unrealistic and even unethical to perform a randomized controlled trial to compare VAL-MAP with the palpation method for the following reasons. First, it would not be a simple comparison between VAL-MAP and palpation, but rather a comparison of palpation with or without VAL-MAP, as was mentioned above. Second, as discussed above, we believe that palpation alone is not always reliable and that VAL-MAP should be used if the targeted nodule meets the criteria for performing VAL-MAP listed in *Table 1* of one of our studies (10) and reproduced here. These criteria have been devised for lesions that cannot reliably be palpated. Third, once VAL-MAP is conducted routinely, it would not be realistic to operate without it, particularly when a targeted nodule meets the indications for VAL-MAP. Indeed, our group discussed planning such a study; however, most surgeons disagreed with the idea, stating that it would not be ethical to plan surgery accompanied by palpation alone, given that VAL-MAP is readily available and an established technique with minimal risks.

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Footnote

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